REMARKS

Claims 1 and 4-16 are pending. Claim 1 is amended in response to the Examiner's rejection and to further clarify the claim. Claim 21 is new. The amendment and the new claim are supported, without limitation, at paragraphs 67, 70-71 and 73-76 of the specification. No new matter is added. Based upon this amendment, and the remarks below, Applicants request that the Examiner reconsider and withdraw the rejection of the pending claims made in the Office Action dated December 2, 2009.

Silence with regard to any of the Examiner's rejections is not acquiescence to such rejections, but rather a recognition by Applicants that such previously lodged rejection is moot based on Applicants' remarks and/or amendments. Specifically, silence with regard to Examiner's rejection of a dependent claim, when such claim depends from an independent claim that Applicants consider allowable for reasons provided herein, is not an acquiescence to such rejection of the dependent claim, but rather a recognition by Applicants that such previously lodged rejection is moot based on Applicants' remarks and/or amendments relative to the independent claim (that Applicants consider allowable) from which the dependent claim depends.

Section 103 Rejection

The Examiner rejected claims 1, 2 and 4-16 under Section 103(a) as being unpatentable over Fleute et al ("Nonrigid 3-D/2-D Registration of Images Using Statistical Models"), in view of Cover et al ("Interactively Deformable Models for Surgery Simulation") and Parry et al ("Free-Form Deformation of Solid Geometric Models") and further in view of DiGioia et al ("Computer Assisted Orthopedic Surgery. Image Guided and Robotic Assistive Technologies"). In addition, the Examiner cited Tanaka et al, U.S. Patent 6,692,448 in the rejections.

Reserving their rights to assert that claim 1 in fact is patentable over the five references cited by the Examiner, and in order to expedite prosecution, Applicants have amended claim 1 to clarify that the bone being modeled is an anatomical bone. They have further amended claim1 to provide that "the 3D model is generated in the at least

one suitably-programmed computer by successively comparing at least one 2D anatomical bone image with at least one view of the 3D bone template, computing an associated error, and optimizing 3D bone template free form deformation parameters to minimize said error." As amended, claim 1 is patentable over the cited references, and should be allowed.

The Examiner cited Fleute for teaching an "algorithm for generation of [a] three dimensional model of a bone by reconstruction of 3D shapes using x-ray views and a statistical model." The Examiner further stated that the "3-D model of the patient bones is constructed [in Fleute] by deforming a statistical 3-D model to the contours segmented on the x-ray views. The statistical model (template) is made of a few principal modes that are sufficient to represent the normal anatomy." (Office Action, p. 4)

However, the Examiner acknowledged, "Fleute does not teach using a 3D template to which *a free form deformation* is applied." (Office Action, p. 4) (Emphasis added) The Examiner cited Parry for teaching "deforming solid geometric models in a free-form manner," Cover for teaching "use of 3D models for surgery simulation, such as interactively deformable models that would provide realistic simulation" and Tanaka for teaching "an artificial bone template selection system" and that "templates can be further deformed." (Office Action, pp. 4-5.)

The Examiner then stated that it would be obvious to "use an appropriately selected 3D bone template, including a deformable 3D bone model for fitting of 2D x-ray contours of the bone to an appropriate template." The Examiner further stated that "[i]f there is need to refine a statistical 3D template … one would turn for databases of existing bone templates, such as those described in Tanaka, or if further refinement reflecting individual characteristics is needed, to interactively deformable models addressed in Cover and originally described in Parry." (Office Action, p. 6)

Applicants respectfully disagree that it would have been obvious to combine this large package of references to obtain the limitations of claim 1. The Examiner's combination of the 5 references reflects impermissible hindsight.

Moreover, even combining all five of the references cited by the Examiner would not provide the features of claim 1 as amended.

In particular, and without limitation, there are at least two features of claim 1 as amended not disclosed in the references, even when the references are combined:

(1) the automatic determination of the required free form deformation parameters, by minimization of a computed error; and

(2) the use of free form deformation to create a model of an anatomical bone *that is not limited to a pre-existing set of templates*, but necessarily may include abnormal features.

The Examiner has acknowledged that "Fleute does not teach using a 3D template to which a free form deformation is applied," to generate a 3D model of an anatomical bone, as required by claim 1.

While Parry teaches "deforming solid geometric models in a free-form manner," it does not teach using free form deformations in order to generate models of anatomical bones. While Cover teaches "use of 3D models for surgery simulation, such as interactively deformable models that would provide realistic simulation" it also does not teach using free form deformation to generate models of anatomical bones. Rather, it teaches use of free form deformation for a vey different purpose: to permit simulation of surgery, whereby a user may determine the deformation to a soft organ (such as a gall bladder in Cover's example) in response to manipulation by the surgeon. Thus, Parry and Cover, in combination with Fleute, do not teach using "a 3D bone template … to which a free form deformation is applied" to generate a 3D model of an anatomical bone, as required by amended claim 1. Nor would it be obvious to apply free from deformations to 3D templates to generate 3D models of bones, based on the Fleute, Parry and Cover references.

Tanaka teaches applying fee from deformations to bone templates. However, Tanaka, even combined with the previously-discussed references, does not render

amended claim 1 obvious; Tanaka does not disclose at least the two limitations of amended claim 1 set forth above.

First of all, and most critically, in Tanaka the free form deformation is carried out manually by an operator viewing the bone and template on a display. (col. 9, lines 58-64) There is no disclosure in Tanaka of any method of processing the anatomical bone image data and the bone template data to determine an optimal 3D bone template. More specifically, there is no disclosure in Tanaka of the special method set forth in claim 1, of successively comparing the template to anatomical bone image data, computing an associated error, and optimizing the free form deformation parameters by which the template is deformed to minimize the error. Thus, for this reason alone, amended claim 1 is patentable over Tanaka and the other cited references.

Second of all, Tanaka discloses using free form deformation of bone templates for a very different reason than such deformations are used in amended claim 1, and it uses them in a very different way. Tanaka does not disclose the use of free form deformation to create a model of an anatomical bone that is not limited to a pre-existing set of templates, but necessarily may include abnormal features. In Tanaka, as the Examiner notes, the objective is much more limited; it is only to find a single most suitable bone template from a collection of templates. An artificial bone in the shape of the chosen template is then used to replace an anatomical bone. (Office Action, p. 5; Tanaka, Abstract) In that context, Tanaka teaches that a user may compare one or more templates to a bone and select one of the templates to order as a replacement artificial bone. (col. 6, line 65 to col. 7, line 14; col. 10, lines 14-19) Thus, although Tanaka discloses free form deformation of a template, Tanaka uses that deformation only for the very limited purpose of finding *another* template that is a better match to the bone than the deformed template. (col. 5; lines 51-62)

Turning specifically to the Examiner's comments, the Examiner stated that "[i]f there is need to refine a statistical 3D template … one would turn for databases of existing bone templates, such as those described in Tanaka." (Office Action, p. 6) However, it is an important feature of amended claim 1 that the 3D model of the

anatomical bone which is generated is *not* limited to being chosen from a pre-existing database of existing bone templates, but rather that it can be optimized as necessary *starting from such a template* by manipulation (in particular, free form deformation) to resemble the anatomical bone as closely as required or desired, regardless of the shape of the anatomical bone.

The Examiner further stated that "if further refinement reflecting individual characteristics is needed, [one would turn] to interactively deformable models addressed in Cover and originally described in Parry." (Office Action, p. 6) However, as discussed above Cover describes deformation of an anatomical structure, not for the sake of more closely matching an anatomical feature, *but rather for the sake of teaching a surgeon how an anatomical feature will deform upon being manipulated in surgery*. (Indeed, Cover models soft organs such as gall bladders, not hard structures such as bones.) Thus, nothing in Cover teaches how to manipulate models by free form deformation to more closely match an existing structure.

Insofar as Tanaka does not disclose these limitations of amended claim 1, and the other references cited by the Examiner also do not, it follows that amended claim 1 is patentable over the Tanaka and the other cited references.

Claim 2 was previously canceled.

Claims 4-16 depend from claim 1. Insofar as claim 1 is allowable over the above-cited art for the reasons set forth above, claims 4-16 also are allowable.

New claim 21 depends from claim 1. Insofar as claim 1 is allowable over the above-cited art for the reasons set forth above, claim 21 also is allowable. In addition, none of the references cited by the Examiner teach determining free-form deformation parameters by using adaptive refinement of a control block, as claimed in claim 21. Claim 21 is allowable for this reason as well.

CONCLUSION

Applicants submit that the pending claims are now in condition for allowance, and request such action.

The Commissioner is hereby authorized to charge an extension fee, together with any further amount required for proper filing of this paper, to our Deposit Account No. 06-1448, Reference CMV-005.03.

Applicants invite the Examiner to contact the Applicants' Attorney if questions arise regarding this Response.

Respectfully submitted,

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